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ABSTRACT

Basic research into the mechanisms and functions of the brain carried out in the past 25 years has provided evidence that humans do, indeed, experience two ways of knowing. More recent research has explored the nature of the apparent perceptual bias--or way of knowing--of each brain hemisphere, and this information, which has changed thinking about the brain, has profound implications for all educators. A review of research confined to the procedures applied by the brain in processing materials specific to the language arts yields a number of implications for teachers in that field, including the following: (1) all materials should be presented as a whole and as parts of a whole; (2) less material should be covered, allowing students to approach the concepts using as many modalities as possible; (3) students should be allowed to explore new processes and ideas and to play with ideas; (4)reading and writing activities should be extended to include informal conversation, rhythmic and physical interpretations, and creative dramatics activities; (5) new associations between ideas should be encouraged, and their expression rewarded; and (6) literature rather than basal readers, should be the choice of materials for all language arts activities. (FL)

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BRAIN RESEARCH AND THE LANGUAGE ARTS

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BRAIN RESEARCH AND THE LANGUAGE ARTS

Much I owe to the lands that grew--
    More to the Lives that fed--
But most to the Allah Who gave me
Two
    Separate sides to my head.

Much I reflect on the Good and the
True
    In the faiths beneath the sun
But most upon Allah Who gave me
Two
    Sides to my head, not one.

I would go without shirt or shoe,
    Friend, tobacco or bread,
Sooner than lose for a minute or
Two
    Separate sides of my head! [1]

Rudyard Kipling
enlarged from Kim

Basic research into the mechanisms and functions of the human brain carried out over the past twenty-five years has provided evidence that Kipling was correct. Humans do indeed experience two ways of knowing--in the separate sides of their heads. More recent research has explored the nature of the apparent perceptual bias--or way of knowing--of each hemisphere. This information, which has changed the ways we think about the brain, has profound implications in education.

Using the foundation of data generated by basic brain research, specialists in education have examined the processing strategies that appear to be inherent in each half of the brain, as well as the ways in which the two hemispheres seem to cooperate in the learning and thinking processes. Numerous projects have examined the procedures applied by the brain in processing materials specific to the language arts subject areas, the results of which have allowed theorists to develop experimental teaching techniques and new approaches to teaching the whole child. Some of the techniques and approaches have further application across subject areas, and their utilization may allow both educators and the creators of text materials to enhance the learning, and more important, the thinking of every student.

The father of modern brain research, Professor Roger Sperry, acknowledged the potential impact of his pioneering work on the teaching/learning phenomenon in his Nobel Prize lecture delivered

in Stockholm in 1981, when he said:

> The more we learn, the more we recognize the unique complexity of any one individual intellect and the stronger the conclusion becomes that the individuality inherent in our brain networks make that of fingerprints or facial features gross and simple by comparison. The need for educational tests and policy measures to identify, accomodate, and serve the differentially specialized forms of individual and intellectual potential becomes increasingly evident.[2]

In an earlier article in SATURDAY REVIEW in August, 1975, Sperry, whose work has created the framework for most of the contemporary research in neurobiology and neuropsychology, indicated two ways in which he believed that knowledge of the brain's functions should affect the approaches used in the education of students. The first "involves a direct break with long established materialistic and behavioristic thinking,"[3] and the second involves changing the emphasis of an educational system that "discriminates against one whole half of the brain, (with) training lavished on the left. . . hemisphere"[4] to the neglect of the right.

As a young doctoral student at the University of Chicago, the researcher had already rejected the behavioristic model of "function follows form," that the brain is shaped by the

experiences of the individual, which was the theory of his mentor, Professor Paul Weiss. Much of Sperry's graduate work was involved with split brain studies using animals, and by the early 1950's, when he was invited to be the Hixon Professor of Psychobiology at Caltech, his papers concerning brain mechanisms and perceptual process had already made Sperry a world leader in brain research.[5] At Caltech, the patients of neurosurgeons, Drs. Joseph Bogen and Phillip Vogel, who had undergone commissurotomy for treatment of epileptic seizures, presented a unique opportunity to study brain function in humans that closely paralled his work with animals.

Commissurotomy involves the splitting of a large group of nerve fibers, called corpus collosum, that join the left and the right hemispheres of the cerebrum. That the human nervous system is organized so that each cerebral hemisphere receives information from the opposite half of the body had been acknowledged for more than a century, but because the neural pathways carrying information from the sensory organs to the brain cross at a point that is physically lower in the brain than the corpus collosum, and because the function of the corpus collosum was unknown, the researchers expected commissurotomy patients to experience little or no behavorial or personality effect from the surgery. In working with these patients, a great deal was learned about the role of the corpus collosum, but far more was learned concerning concerning the processing functions of the brain itself, an unanticipated coincidence.[6]

Using dichotic listening techniques and schleral lens techniques that allowed stimuli to be presented to each hemisphere of the brain separately, and by creating tasks that called for either a verbal response or a choice response from an array of of objects when the subjects were presented with visual stimuli,[7] Sperry and his colleagues found that the corpus collosum was of critical importance in allowing stimuli perceived by one hemisphere to be transferred to the other, and in allowing coordination of the perceptual strength of each hemisphere. In fact, the bundle of nerve fibers was found to be so vital to communication between the hemispheres that it was as if, when the pathway was no longer available, the brain became divided or split, with one realm of consciousness totally separated from the other. The extensive testing gave evidence that, in commissurotomy patients, each hemisphere contained a conscious realm of experience that remained totally unaware of stimuli received by the opposite hemisphere.[8]

These data led researchers to a notion of hemisphericity, or the lateralization of abilities in normal subjects as well. Tests with normal subjects supported the thesis. Hemisphericity is the assumption that specific functions are indigenous to each hemisphere. Lateralization refers to the concept that each human has a dominant hemisphere, and therefore tends to use the processing functions of that hemisphere in processing stimuli. Tests indicate that the dominant hemisphere reacts a split

second before the other, and thereby controls the cognitive strategy bias of the individual. Lateralization is analagous to handedness. Although most humans can use either hand for many functions, the normal person has a bias toward using one hand in preference to the other. Similar bias is thought to exist in the brain.

Because Sperry's subjects were able to use language in describing the stimuli presented to the left hemisphere, the notion that language as a function was lateralized in the left have of the brain became an important concept in the theory of hemisphericity. Because the commissurized subjects were unable to use words in their responses to stimuli presented to the right hemisphere, but did respond by matching pictures and making selections from a choice array of objects, the early assumption was that the right half of the brain lacked language abilities, but was able to respond in a more "primative" fashion to visual stimuli.[9]

Using lateral eye movement studies, bias toward the use of one hand in preference to the other, and timed verbal response tests, several researchers working with normal, non-commissurized subjects concluded that in a majority of normal humans, the bias called lateralization was toward the left hemisphere, if the person were right-handed, and toward the right side of the brain if the person were left-handed. Because a majority of the subjects were right-handed, and because a majority presented test evidence of having left hemisphere speech/language abilities, lateralization

toward the left hemisphere became the norm, if not the ideal, of the 1970's. The ideal of a left hemisphere bias was so prevalent that Professor Stephen D. Krashen, of the Linguistics Department at UCLA, wrote in 1977 that "certain individuals never attain the 'adult' level of cerebral specialization of functions,"[10] meaning a left hemisphere bias. In most cases, he noted, cultural deprivation appeared to be a factor in this "failure," except for those who were either left-handed or female. Those failures he found difficult to understand. Such prejudice toward one perceptual bias could hardly fail to color both the literature and the experimental research of the 1970's, and should be considered in examining the data generated during that period.

For several years, the left hemisphere was referred to as the "Major" hemisphere, and the right side as the "minor" hemisphere, by many researchers in the field. The terms may occasionally be found in the contemporary literature. Professor Robert Nebes of the Duke University Medical Center Department of Psychiatry, writes in THE HUMAN BRAIN that the left hemisphere "was the first found to possess a cognitive function unique to it. . . (so) it seemed logical that the hemisphere in which comprehension and production of language takes place should be more highly developed, and in control of the rest of the brain. . . the prevailing theory for many years was that. . . all higher mental functions were carried out in the left hemisphere."[12]

It was assumed that the hemisphere that controlled speech also controlled the production of language, and therefore of all higher mental functions. A popular notion developed that a left hemisphere bias was somehow superior to the processes of the of the right side of the brain.

These popular notions were so deeply ingrained in the data and the literature concerning his work, that Sperry addressed these assumptions in his Nobel Prize lecture in 1980, when he said that:

> Further developments from. . . (sources other than basic brain experiments) have advanced in many directions. . . (However), in some cases the conclusions along with the growing wave of semipopular extrapolations and speculations concerning "left-brain" versus "right-brain" functions call for a word of caution. The left-right dichotomy in cognitive mode is an idea with which it is very easy to run wild. Qualitative shifts in mental control may involve up-down, front-back, or various other organizational changes as well as left-right differences. Furthermore, in the normal state, the two hemispheres appear to work closely together as a unit, rather than one being turned on while the other idles. Much yet remains to be settled in all these matters. Even the main idea of differential left and right cognitive modes is still under

> challenge . . . in favor of the view that the right hemisphere specialities are primarily praxic or 'manipulospatial' and that higher cognition and self awareness are associated mainly with language in the left hemisphere.[13]

Heeding Professor Sperry's cautions, the data generated by other researchers merits closer examination. The work of Neils Lassen and David Ingvar, using radioactive isotopes that can be traced through the brain, the mapping of cognitive activities using positron emission tomography (PRT) by Martin Reivick and Michael Phelps, and the experiments of Dr. George Ojemann with his neurosurgery patients extends the data of Sperry and his colleagues, and indicates a more complex organization of functions than would be possible given the concept of total lateralization.

The blood flow studies of Lassen and Ingvar indicate a "small but highly significant hemispheric difference of about three percent in blood flow,"[14] when subjects were engaged in verbal analogies tasks as compared to activities in picture completion tasks. Small differences between the front of the brain and the back in demands of blood flow were noted also. The PET studies at UCLA and at the University of Pennsylvania, investigating the location of metabolic activity in the brain during specific tasks, indicate a greater blood flow activity in the left hemisphere during oral language tasks, but the right

hemisphere shows activity as well. When subjects were involved in spatial tasks, the right hemispheres of subjects showed greater activity, but the left hemisphere was far from inactive. Their data, gathered durring recent work, indicate that in normal persons, most activities involve some cooperation between the two hemispheres, involving the function of the corpus collosum.[16]

The recent studies of neurosurgeon, Dr. George Ojeman at the University of Washington, indicated the possibility of an even greater degree of specificity involved in processing certain stimuli, particularly language and mathematics. During brain surgery, Dr. Ojemann probed various sites within the brains of his patients with electrodes. Depending on "what he touched, they found themselves unable to speak the noun, the preposition, or other part of speech."[17] He also found that bilingual patients the same word in each language in different areas of the brain. Based on his experiences, Dr. Ojemann indicates the possibility that the brain may have more than one method of organizing language, as well as of storing words. Some patients, he found, "have sites for naming objects in their parietal lobes that ordinarily receive sensations of touch and spatial information," while others have "these naming sites in the temporal lobes, amid regions devoted to hearing and memory."[18] These data open the way for exploration into the differences of organization and storage within the brains of individuals of the elements of

language, and/or other symbolic representations that are part of the learning process, as well as part of the experience of each individual.

Work with normal, brain damaged, and learning disabled subjects at the Montreal Neurological Institute by Doreen Kimura in the early 1970's had already pointed toward what Sperry called the individuality inherent in our brain networks."[19] Although Kimura found that a majority of her subjects exhibited a left hemisphere superiority for the processing of the sounds of the human articulatory system in dichotic listening tests, a small minority of those studied, demonstrated a reversal with definite superiority for speech/language processing in the right side of the brain. This right brain lateralization of speech, if not language, was supported by subsequent sodium amytal tests, developed by John A. Wada.[20] The significance of Kimura's data concerning the possibility of a number of persons whose processing strategies do not fit the norm is of special interest to educators.

The majority of subjects in the Montreal tests, however, evidenced a specific attunment to the sounds of human speech in the left hemisphere, perceived through the right ear. This superiority held true for the vowel-consonant syllables such as those that make up the phoneme systems of spoken languages, and extended into musical sounds, which are normally processed in the right hemisphere. When melodies were hummed by the human voice, they were processed through the left hemisphere more

accurately.[21] Such data would prompt researchers to ask if the "language" superiority might be simply a "speech" superiority, if it were not for other data compiled in the same tests that point to a right visual field/left hemisphere superiority for processing both words and letters. Further tests indicated, according to Kimura, that deaf subjects process sign language faster and more accurately with the right hand/left hemisphere, and that the same was true of blind subjects using Braille.[22]

A vast amount of research data points to the possibility of lateralization of specific functions, such as language processing and visuo-spatial processing within individuals, although the specifics of brain organization are among the least agreed upon topics in neurophysiology. Recent studies by Jeanette McGlone of Ontario with victims of cerebral damage and the analysis of sex-difference research by Diane McGuinness and Karl Pribram at Stanford indicate that still another factor may be significant in the processing strategies within the brain of any individual, that of the sex of the person.

McGlone's studies of the effects of tumors and cerebral accidents or strokes on the functions of the two hemispheres indicate that males are more lateralized, "their functions were more specialized to either the left or right hemisphere," while the brains of females appear to have the functions far more evenly distributed throughout the brain. McGlone's findings are supported by the eeg studies of psychologist Richard Davidson

and his colleagues at Harvard in which the conclusions were that females " are better at activating the two hemispheres at once, and at turning one side down while the other side is turned up."[24] In an attempt to correlate and clarify the work that has been completed in studying sex-differences, McGuinnes and Pribram complied an analysis called "The Origins of Sensory Bias in the Development of Gender Differences," and came to the supporting conclusion, after reviewing a voluminous amount of material, that males and females may actually experience the world differently.[25] Males and females appear to possess inherent differences in the perceptual strategies they employ in processing stimuli.

The implications of these theories for educators are of great significance since the average classroom is made up of both males and females,who are being asked constantly to process materials in one specific way or another. However, Dr. Elmer Green, biopsychologist, who directs the Voluntary Controls Program at the Menninger Foundation, and who is a leader in the research of the use of biofeedback training, believes that the primary mistake made by researchers in neurophysiology, is "to assume that all these right/left hemisphere abilities are hard wired. . . which hemisphere controls which side of the body, hard wired, the rest isn't. It can be changed through training."[26] Dr. Green believes, from his work with dyslexics, that all humans can be trained to have access to all of the abilities of the brain.

Educational research by E. Paul Torrance and his associates at the University of Georgia is based on this premise. That a specific bias can be ascertained by testing, and that training can change the direction of the bias as well as create integrated thinkers, was the subject of one of the many studies of perceptual bias done by Torrance. The concluding data suggest "that an individual's preferred style of learning and thinking might be modified over a relatively brief time period . . . and that the general direction of the change can be controlled."[27]

If, as hypothesized by Eric Lenneberg, psychologist at Cornell University, "lateralization of the function in the brain develops over time, but is complete by puberty,"[28] and if the work of neurologist L. S. Basser, upon which Lenneberg's work is based, is accurate in its conclusions that "the severity of impairment is directly related"[29] to the age of the child when severe damage occurs to either hemisphere of the brain, the years that a child is in school are of cardinal importance in developing integrated thinkers. In his patients, Basser found that in those children who underwent hemispherectomy (the removal of one entire hemisphere of the brain), if the surgery were performed in early infancy, "no signs of lateralized deficits in higher mental functions remain in adult hood."[30] The remaining hemisphere appears to be able to take over the functions of the the other half of the brain. Consequently, within the age span that substitution can take place in brain damaged subjects, it

may be projected that the training of students having normal brain functions might be most advantageous.

In fact, two studies have recently examined the possibility that the left sensory bias for language processing that appears to be the norm in Western society may be the result of our left-to-right system of written language. The Shimrat study in 1973[31] of children who wrote Hebrew, and the Biederman and Tsao study of 1979 examined adults who wrote Chinese.[32] Such studies are an attempt to learn if a particular hemispheric bias is inherent of learned. Thus far, the results have been inconclusive.

Other questions of general educational significance have been probed using the data from the basic brain research, in a wide span of topics, ranging from those investigating the physical positions of students in the classroom and the possible effects of those locations on language proficiency,[33] to inquiries into the possibility that Black-White differences in IQ test scores may be related to a White, middle class sensory bias toward left hemisphere verbal, sequential processing strategies that are less a part of the minority experience.[34]

The use of Galen's Word Shape Sorting Test as a means of determining hemispheric bias in the processing strategies of students has been investigated at the University of South Florida,[35] using eeg studies of the emotional reactions of students to visual violence in a film. Their findings appear to further validate the test.

Another study in education that was based on the early brain research, and that may have application across subject areas was that of Rice and Languis, in which it was discovered that students faced with incongruent visual and verbal stimuli tended to believe the nonverbal information, in preference to the verbal message.[36]

Within the two major areas of the language arts, reading and writing, a plethora of specific studies have been undertaken utilizing the data from the medical and psychological studies of the brain's processes. A number of them offer insights into the ways that students learn, and may offer now possibilities for educators to tap the mental strategies of students in order to teach them more effectively.

Yvonne L. Turner concluded that students who appeared to use right hemisphere perceptual strategies in approaching written material have lower scores on standardized reading comprehension tests. She also concluded that the right hemisphere processes the prose aspects of written material, while the left analyzes phonemes and syntax.[37]

John Kershner's studies of disabled readers, good readers, and gifted children led him to the conclusion that " reading impairment is a text-specific problem, and is not derived from a general language disturbance . . . (which) may result (from) a perceptual coding strategy that is inappropriate to the processing demands made by comprehending text, and may be inefficient for the achievement of academic success via orthodox

instruction . . . " Kershner seems to believe that poor readers are not using the same perceptual strategies to decode the material that good readers use, because poor readers have a bias toward the opposite mode, and that traditional teaching practices will only help such readers to fail.[38]

Symmes and Rapoport found that poor readers who were tested as being within norms for preception and intelligence made above average scores on visualization tests,[39] as did Levin, who found a comparable group through standardized reading tests. Levin, however, identified another group of poor readers who had decoding skills, but lacked organizational skills in reading. By simply teaching the second group visualization skills, thought to be a right hemisphere strategy, the scores on reading comprehension were raised by 40 %.[40]

From these studies, it appears that readers who process written material using a predominantly left hemisphere strategy of sequencing, without integrating the right hemisphere visualization strategies, may be able to read, but not comprehend. Those readers who appear to have good visualization skills, but who lack the sequencing skills of the left, have great difficulty in developing overall reading skills. As Patricia L Fox wrote in her article in THE READING TEACHER in October, 1979, "Good readers seem to integrate the verbal and the visual aspects of reading unconsciously. . . .[41] She then hypothesizes that the exercises in visualizing may be of value in tapping

the right hemisphere strategies already applied by students with a strong right laterality, and may enhance the reading skills of those students whose perceptual bias is strongly toward the left hemisphere's processing strategies.

In the same article, Fox relates the bi-hemispherical processing strategies to the chimera study carried out by Sperry with the commissurotomy patients.[42] Those data indicated that split-brained subjects created or visualized the missing portion of a picture when a"chimera" consisting of half a rose or half a face was presented to each hemisphere separately. Both hemispheres indicated by their answers that the entire picture of each visual was presented. Each hemisphere generated a complete picture from the part. Fox relates that Frank Smith calls this "generative processing," and she hypothesizes that humans can complete sentences and pictures according to expectencies . . . (that) readers anticipate meaning based on prior knowledge of semantics, syntax, and subject matter. . . . (and that) with increasing skill readers depend less on decoding skills and more on generative skills."[43]

M. C. Wittrock, professor educational psychology at UCLA states in THE HUMAN BRAIN that the generative model emphasizes "that verbal processes and imagery can be used to construct meaning for events and subject matter. . . "[44] According to Fox, the generative model applies to the reading process. Sharon Crowley, in a paper presented at a conference on college composition

in Denver in 1978 states that the generative model is imperative to the teaching of written composition, another of the most important aspects of the language arts. She states that "because composition is one of the few "bispheral" activities, (that) the left and right brain functions seem to alternate during the writing process, supplementing the insights of each other." She postulates, however, that in the current teaching of writing, the left hemisphere model, using reason, facts, and objective quality is neglecting the strengths of the right hemisphere, emotions, values and opinions.[45] Thomas Gage in a paper presented at the Sociolinguistic Conference in SanFrancisco in 1977 supports this view. He views the composing process not only as "bispheral," but as mutually supportive of one another in the various roles necessary from the time a writer "spills out lumps of think" onto the paper, until the lumps of think have been organized and sequenced, organized written discourse.[46]

Benjamin Glassner has empirically supported the premise that writing is a whole-brained activity with eeg studies of students done while they were writing. His findings concluded that during the writing of a factual account of information extensive material, the left temporal lobe of the brain showed greater eeg activity, but that reflexive writing caused greater right temporal lobe activity. He suggests that traditional instructional methods are unsuccessful in the teaching of written composition, because they are "half-brained.."[47]

Richard Sinatra, in a paper presented to the International Reading Association in 1979, stated that visual strategies can be used to involve students in the writing process, and to teach them to order their experience visually, then to transfer that order and sequence to their verbal output,[48] while the original studies by Sperry and his associates remind the teacher of writing that drawing on one of the strengths of the right hemisphere, as demonstrated by the early commissurotomy patients, can add richness and color to discourse written by students. The right hemisphere has shown a remarkable ability to make metaphors and analogies that should be utilized in enhancing student writing.[49]

In the teaching of written composition, as well as in the teaching of reading and the other language arts, some insights into the processes that are happening within the brains of the students we teach, can be of value only if those insights are applied to the techniques and materials presented to and involving students.

Two broad gerenalizations about the functions and processes of the human brain are supported by a wide range of data. They are that the "left hemisphere appears to specialize in data whose significance is built across time . . . while the right is specialized in data whose significance is build across space. . ." To summarize the statements of several researchers, the right hemisphere of the average human brain appears to process stimuli as a gestalt, and to process visual materials, as well as musical

tones more effectively than the right hemisphere. It seems to act as a synthesist, to use intuition and leaps of insight , and to be more subjective, relational and time free, while it thinks in more appositional and divergent ways. The left hemisphere appears to perceive details, to analyze and to sequence, using a step-by-step logic, and to think in propositional, divergent ways. In short, the left hemisphere seems to perceive and to process information in parts, while the right hemisphere perceives and processes information in wholes.

What are the implications of these data to educators, specifically to those teaching in the language arts?

First, to honor the two separate sides of the head inside each student, all materials should be presented as a whole, and as the parts of the whole. When the material has been internalized by the student, further exercises in generative processing of similar materials in both directions, from wholes to parts, and from parts to wholes, should be attempted. Generative processing should occur only when a student has mastered the whole/part concepts. Whenever possible, materials should be presented as verbal, visual, manipulateable, physical, and through whatever other intrepretations to which the materials can be adapted.

Second, less material should be covered, allowing students to approach the concepts using as many modalities as possible, and encouraging repetition of the important concepts.

Third, students should be allowed to explore new processes and ideas, and should be allowed to "play" with ideas. Playing mind games should be encouraged, along with observation by the students in order that they may themselves determine how they learn most successfully.

Fourth, reading and writing activities should be extended to include informal conversation, rhythmic and physical interpretation such as dance, and creative dramatics activities to allow the student to "experience the distant in time and place, and to order that experience," according to Dorothy Heathcote. Visual activities should be encouraged also for each new concept, and students should be allowed to choose the media and method by which to present the same concepts that they present verbally.

Fifth, new associations between ideas should be encouraged, and their expression should be rewarded. Ideas that demand holistic processing should be a part of every day's class activities.

Sixth, the highly structured verbal sequencing activities that are currently so popular should be supplemented with unstructured activities.

Seventh, the skills of visualizing should be taught actively as the step-by-step sequencing of verbal materials is now taught.

Eighth, the sequencing of data to be learned across both time and space, whenever the materials can be adapted, to reinforce the strengths of each hemisphere of the brain in learning new concepts.

And ninth, literature should be the choice of materials for

all language arts activities, rather than basal reading texts, in order to provide students with what Northrop Frye calls "the verbal element in the training of the imagination . . . the constructive power of the mind."[51]

For, as Professor Robert Nebes of Duke University Medical Center Department of Psychiatry, writes:

> If there is any truth in the assertion that our culture stresses left-hemispheric skills, this is especially true of the school systems . . . If the right hemisphere does indeed process data in a manner different from the left, we may be shortchanging ourselves when we educate only left-sided talents in basic schooling . . . Many problems can be solved either by analysis or synthesis; but if people are taught to habitually examine only one approach, their ability to choose the most effective answer is diminished . . .[52]

Our reading/listening and talking/writing emphasis in all of the language arts may be handicapping not only the proportion of students whose perceptual strategies are not tapped by current teaching strategies and learning materials generally used in schools , but as educators we may allowing, if not actually encouraging, the development of a culture made up of people who will be able to use only half of their potential. Drawing upon what we know about the processes of the human brain, the time has come to begin to teach the whole student--in both sides of his head.

NOTES

[1] Rudyard Kipling, RUDYARD KIPLING'S VERSE, ed. Elsie Kipling Bambridge (London, 1891; definitive edition, New York: Doubleday & Company, 1940), p. 231.

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[3] Roger W. Sperry, "Left-Brain, Right-Brain," SATURDAY REVIEW, 2, No. 23, 9 August 1975, pp. 30-33.

[4] Sperry, "Left-Brain . . .," p. 32.

[5] Michael S. Gazzaniga, "Nobel Prize for Physiology or Medicine," SCIENCE, 214, No. 30, October 1981, pp. 517-518.

[6] Sperry, "Left-Brain . . .," pp. 30-33.

[7] Michael S. Gazzaniga, "The Split Brain in Man," SCIENTIFIC AMERICAN, 217, No. 2, August, 1967, pp. 24-29.

[8] Gazzaniga, "Split Brain . . . ," p. 517.

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[11] Robert D. Nebes, "Man's So-Called Minor Hemisphere," THE HUMAN BRAIN, ed. M. C. Wittrock (Englewood Cliffs, N. J.: Prentice-Hall, 1977) p. 97.

[12]Nebes, p. 98.

[13]Sperry, "Some Effects . . ., p. 1225.

[14] Sally Springer and Georg Deutsch, LEFT BRAIN, RIGHT BRAIN (San Francisco: W. H. Freeman and Co.), 1981.

[15]Sharon Begley, John Carey and Ray Sawhill, "The Human Computer: How the Brain Works," NEWSWEEK , 7 February, 1983, pp. 40-47.

[16] Begley, et al., pp. 46-47.

[17] Begley, et al., p. 47.

[18] Begley, et al., p. 47.

[19] Sperry, "Some Effects. . ., p. 1225

[20]Doreen Kimura, "The Assymetry of the human brain," SCIENTIFIC AMERICAN, 228, No. 3, March, 1973, pp. 2-3.

[21]Kimura, pp. 2-3.

[22] Kimura, pp. 4.

[23] Celeste Fremon, "Female Intuition," PLAYGIRL, March, 1983, p. 82.

[24] Fremon, p. 82.

[25] Fremon, p. 76.

[26] Fremon, p. 83.

[27] Cecil R. Reynolds and E. Paul Torrance, "Perceived Changes in Styles of Learning and Thinking (Hemisphericity) Through Direct and Direct Training," THE JOURNAL OF CREATIVE BEHAVIOR, 12, No. 4,

[28] Springer, p. 132..

[29] Springer, pp. 136-137.

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